

Cancer Therapy

Evaluation of Supervoltage X-Ray—A Review of the Literature

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AT ITS FORTY-FIRST ANNUAL MEETING in December 1955 the Radiological Society of North America held a symposium on supervoltage therapy² to evaluate the further role of 250 kv. therapy. The discussants did not favor junking this modality. While not complete, evidence as to whether supervoltage therapy is better than 250 kv. therapy would seem to be worth evaluation.

There is no question that proportionally the depth dose as measured physically is greater in the supervoltage than in the orthovoltage range. But the meaning of this larger figure when evaluating the effect of supervoltage in curing cancer is not clear.

The results of radiotherapy depend on a very complex set of circumstances. The higher depth dose may and in fact in some cases does produce severe damage to structures in its path about the tumor, and the assumption that a greater number of cures will result because of dose increase must be balanced against the well documented fact, established by the French school of radiologists about 25 years ago, that severe damage to the tumor bed lessened rather than increased the proportion of cures. In any event, a different "dose" is only meaningful if more "cures" result.

In order to evaluate this point, two forms of cancer were selected for review. Cancer of the tonsil was chosen as an example of a relatively accessible tumor, and cancer of the ovary as an example of deep seated disease. All conveniently available articles found in the literature were reviewed and a list was made of the number of cases treated, the number of five-year survivals, and the voltage range. Articles not stating the voltage were not excluded, nor were cases treated with telerradium excluded. The data thus completed were checked by analysis of variance for the significance of the distribution. In both cases (Tables 1 and 2) the groups were random, with about 0.5 per cent chance of a significant variation. In simple language, this means that all cure rates in the groups are identical, differing only because of the accidents of sampling. In order to make this visually evident, data on the two groups were graphically plotted, each cure rate and its standard deviation being given in order of as-

- Statistical evidence is presented to suggest that cure rates achieved by supervoltage are not significantly different from those achieved by orthovoltage in carcinoma of the tonsil and of the ovary.

ending magnitude. Each rate was coded to indicate voltage. These graphs (Charts 1 and 2) well show the random distribution of the voltage keys. In fact, supervoltage tends to fall in the middle register of one and in the lower register of the other graph.

While there is undoubtedly considerable variance from report to report with regard to distribution of material, this last observation would appear to me to raise serious question as to the possibility of a real difference being obscured. Although this is strictly true of only the two diseases studied, I can see no reason to believe that they are different from other forms of cancer in this regard.

Since this evidence would suggest that the increased cost of supervoltage is not associated with better cure rates, I believe that we should direct our endeavor to more profitable areas. Whether the 200 MEV range has more to offer, or whether we have exhausted the possibilities of improved therapeutics by voltage increase, I cannot pretend to answer.

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TABLE 1.—Data from the Literature on 5-Year Arrests of Carcinoma of Tonsil

Author	Kv. Used	N Number Treated	5-Year Survival	X/N X 5-Year Survival	Per Cent X ²	X ² /N
Berven ¹	H.	46	11	23.9	121	4.8435
Clifton & Harden ⁴	N.	19	1	5.3	1	.0526
Coutard ⁵	180	65	21	32.3	441	6.7846
Dancot ⁶	180-200	89	14	15.7	196	2.2225
Ennuyer & Bataini ⁷	H.	534	96	18.0	9216	17.2584
Friedman and coworkers ⁸	2000	12	1	8.3	1	.0833
Maier ¹⁵	Ra.	47	12	25.5	144	3.0626
Martin & Sugarbaker ¹⁶	200-250	157	26	16.6	676	4.3058
Parschall & Stenstrom ¹⁸	200-220	84	22	26.2	484	5.7619
Scanlon and coworkers ¹⁹	N.	46	20	43.5	400	8.6956
Schall ²⁰	190	75	4	5.3	16	.2133
Schönbauer ²²	Ra.	104	13	12.5	169	1.6250
Sheline, Jones & Morrison ²³	200	25	4	16.0	16	.6400
Sheline, Jones & Morrison ²³	1000	11	2	18.2	4	.3636
Teloh ²⁵	N.	142	7	5.0	49	.3465
Walker & Schultz ²⁶	200	18	1	5.6	1	.0556
Walker & Schultz ²⁶	1000-2000	21	5	23.8	25	1.1905
Total.....						57.5053
Summation all cases.....		1495	260	17.4	$\frac{260^2}{1495}$	= 45.2174
Difference.....						12.2879
$S^2_A = 12.2879 \div 16 = 0.7680$				$\chi^2 = .7680 \div .1437 = 5.3444$		
$S^2_W = .174 \times .826 = 0.1437$				$K = -2.480$		
				$p = 0.9934$		

TABLE 2.—Data from the Literature on 5-Year Arrest of Carcinoma of Ovary

Author	Kv. Used	N Number Treated	X 5-Year Survival	X/N Per Cent 5-Year Survival	X ²	X ² /N
Chu ³	1000	112	29	25.8	841	7.5089
Henderson & Bean ⁹	H.	265	48	18.1	2304	8.6943
Holmes & Schulz ¹⁰	1200	25	6	24.0	36	1.4400
Holme ¹¹	N.	138	49	35.5	2401	17.3985
Jacobs & Stenstrom ¹²	200	31	11	35.5	121	3.9023
Javert & Rascoe ¹³	N.	59	18	30.5	324	5.4915
Kerr & Elkins ¹⁴	200	190	58	30.5	3364	17.7053
Munnell, Jacox & Taylor ¹⁷	180	200	55	27.5	3025	15.1250
Munnell, Jacox & Taylor ¹⁷	250	148	41	27.9	1681	11.3581
Schmitz & Majewski ²¹	800	143	29	20.3	841	5.8811
Sisson & Garland ²⁴	200	135	27	20.0	729	5.4000
Wheelock and coworkers ²⁷	N.	48	13	27.1	169	3.5208
Total.....						103.4258
Summation All Cases.....		1494	384	25.7	$\frac{384^2}{1494}$	= 98.6988
Difference.....						4.7270
$S^2_A = 4.727 \div 11 = 0.4297$				$\chi^2 = .4279 \div .201 = 2.1378$		
$S^2_W = 0.257 \times 0.743 = 0.201$				$K = -2.8191$		
				$p = 0.9976$		

Code for Tables 1 and 2:

Under heading "kilovolts used": N.—not stated; H.—"High voltage" not stated exactly; Ra.—radium bomb teletherapy. The first two of these should be considered in the orthovoltage range, the third supervoltage.

Under the calculations, "K" is calculated by the following formula:

$$K = \frac{\sqrt[3]{\frac{\chi^2}{n-1}} + \frac{2}{9(n-1)} - 1}{\sqrt{\frac{2}{9(n-1)}}} \quad \text{where } n \text{ is the number of lines in the table.}$$

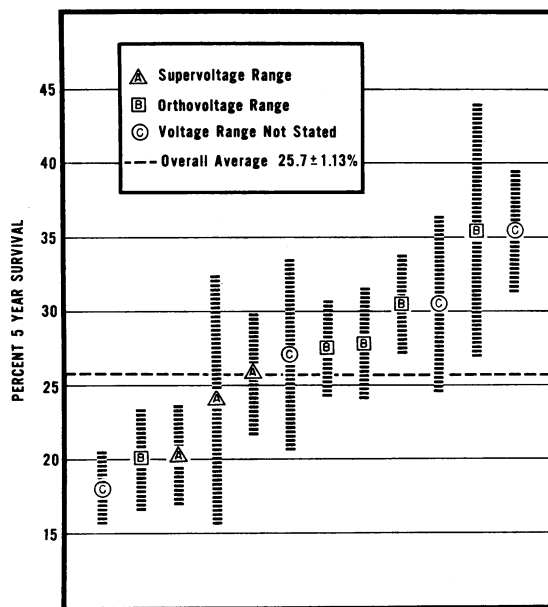


Chart 1.—Results of radiotherapy in carcinoma of the ovary.

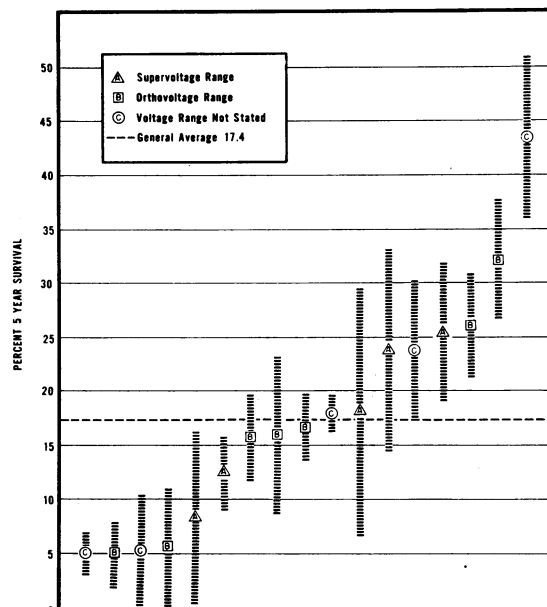


Chart 2.—Results of radiotherapy in carcinoma of the tonsil.

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